MC Flux Fit Using ND Data

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Introduction

- Neutrino flux is not well simulated. Large uncertainties associated with the proton-nucleon hadron production process.
- We can use ND data to correct hadron production simulation and re-weight MC to get better agreement with data.
- Predict FD/ND ratio.

Low-ν Method

Standard neutrino-nucleon differential cross-section:

$$\frac{d\sigma^{\nu(\bar{\nu})}}{dxdy} = \frac{G_F^2 ME}{\pi} \times \left[\left(1 - y - \frac{Mxy}{2E}\right) F_2^{\nu(\bar{\nu})} + \frac{y^2}{2} 2xF_1^{\nu(\bar{\nu})} \pm y\left(1 - \frac{y}{2}\right) xF_3^{\nu(\bar{\nu})} \right]$$

$$\frac{d\sigma}{d\nu} = A\left(1 + \frac{B}{A}\frac{\nu_0}{E} - \frac{C}{A}\frac{\nu_0^2}{2E^2}\right)$$

ν= Eν - Emu

In ν -> 0 limit, cross-section is independent of neutrino energy.

$$N(E)_{\nu<0.5} \propto \phi(E)$$

There will be error from none zero ν, but smaller than error from xsec.

To begin with, will use full CC spectrum.

Parametrization of K/π Production

Parameterize the inclusive invariant cross sections as a function of pT and xR:

F(xR)*G(pT)*H(xR, pT)

Constrain F, G, H using ND data and hadron production data (where availabe)

For example, a BMPT type function:

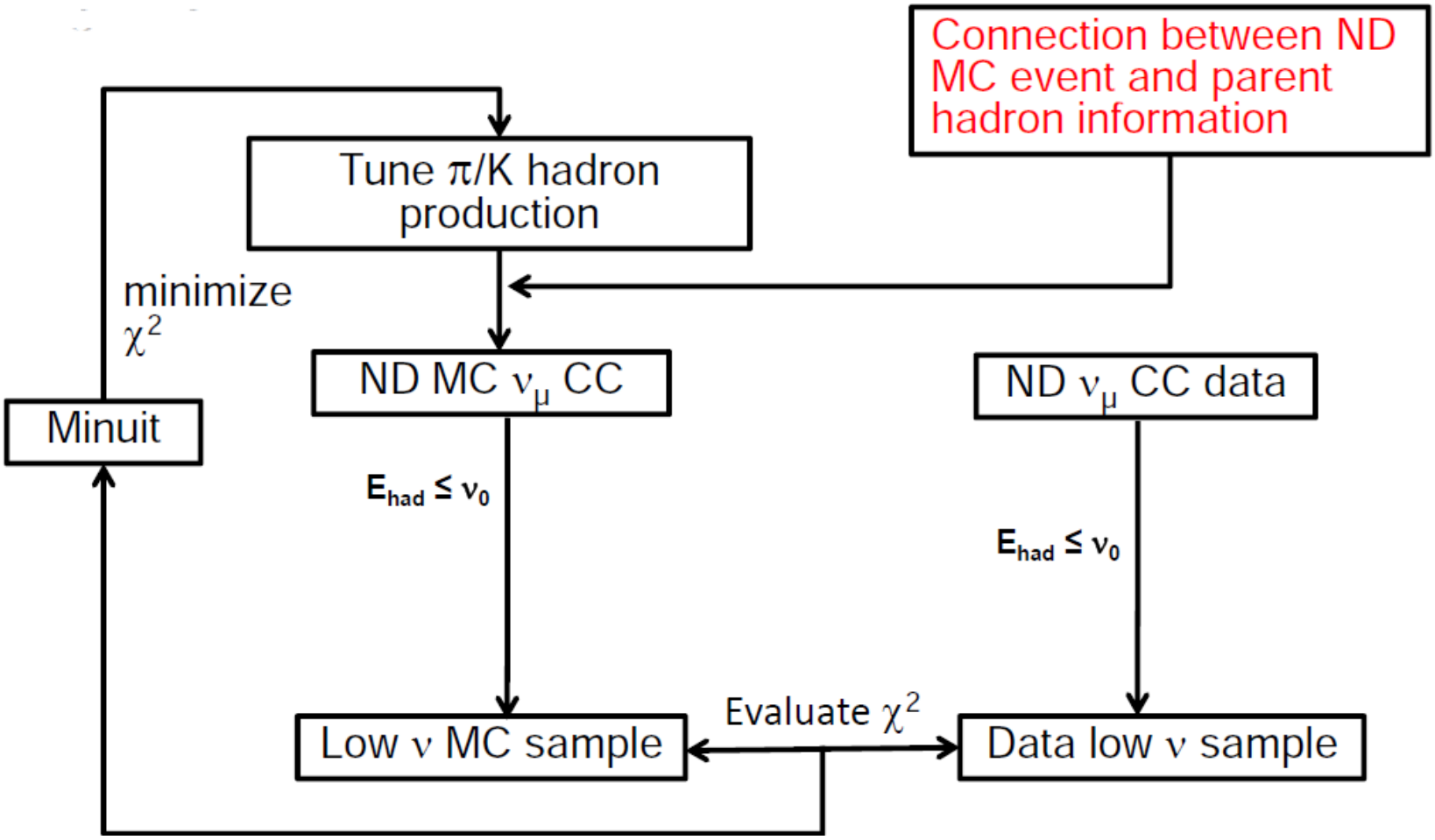
$$\left(E \times \frac{d^3\sigma}{dp^3}\right) = A(1-x_R)^{\alpha}(1+Bx_R)x_R^{-\beta} \times \left(1 + a'(x_R)p_T + b'(x_R)p_T^2\right) e^{-a'(x_R)p_T}$$

Constrain the π+/π− and K+/K- ratio

$$r(\pi) = 1.05 \cdot (1+x_R)^{2.65}$$

$$r(K) = 1.15 \cdot (1-x_R)^{-3.17}$$

Fit Process


Connection between ND MC event and parent hadron information
Tune π/K hadron production
minimize χ^2
ND MC ν_μ CC
ND ν_μ CC data
Minuit
$E_{had} \leq \nu_0$
$E_{had} \leq \nu_0$
Evaluate χ^2
Low ν MC sample
Data low ν sample

Plan

- Start with NDOS data.
- Use both G4NUMI and Fluka beam MC simulation.
- Use ND data when it's ready.
- Predict FD/ND central value.
- Also use hadron production data if available. (This allows for getting an error band.)
- Combine with Minos+ flux fit result.

The End